# High-Resolution (6-12 meV) Threshold Photoelectron Spectroscopy of Argon from 28 to 49 eV

M. C. A. Lopes,[1,2] A. J. Yencha,[3] G. C. King,[1] J. D. Bozek,[4] and N. Berrah[5]

[1]Department of Physics and Astronomy, Schuster Laboratory, Manchester University, Manchester M13 9PL, UK
[2]Departamento de Fisica, ICE, Universidade Federal de Juiz de Fora, Juiz de Fora - MG, CEP 36036-330, Brazil
[3]Department of Chemistry, State University of New York at Albany, Albany, New York 12222, USA
[4]Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA
[5]Department of Physics, Western Michigan University, Kalamazoo, Michigan 49008, USA

## INTRODUCTION

We have measured the threshold photoelectron (TPE) spectrum of argon at high resolution (6-12 meV) using synchrotron radiation on beamline 10.0.1.2 of the Advanced Light Source over a wide spectral range (28-49 eV) encompassing the $(3s)^{-1}$ $Ar^+$ main line, the entire associated satellite ionization region, and the onset region of the doubly ionized Ar states $^3P$, $^1D$ and $^1S$. These basic features are displayed in the overall high-resolution spectrum shown in Fig. 1.

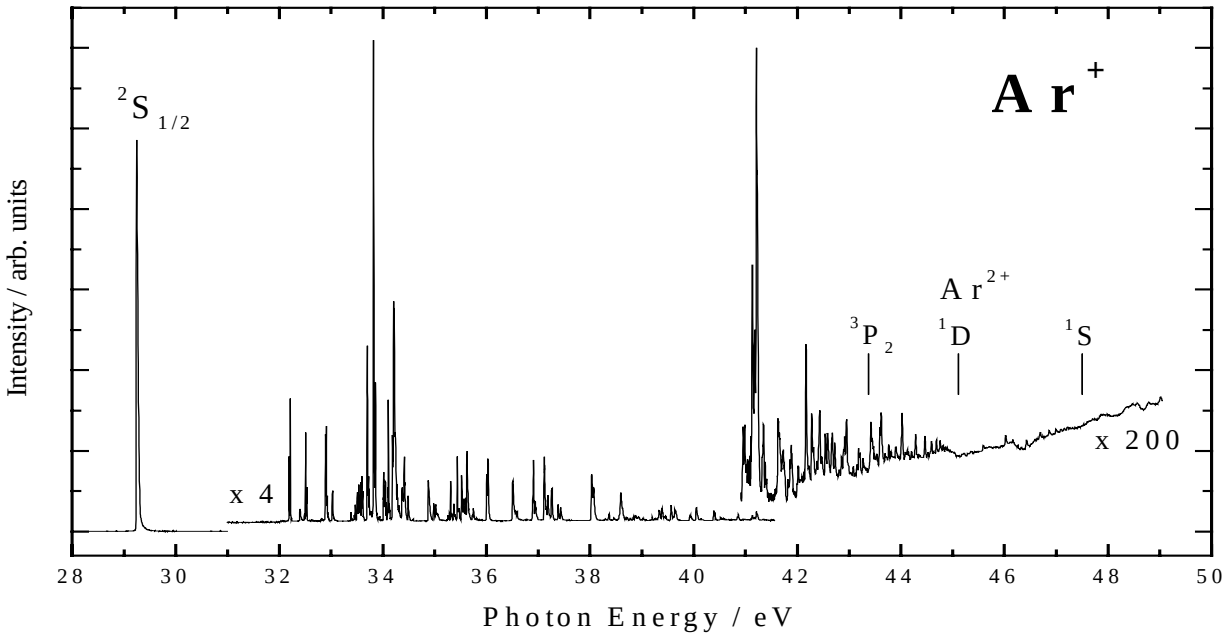


Figure 1. Overall view of the high-resolution threshold photoelectron spectrum of Ar in the 28-49 eV region.

## RESULTS AND DISCUSSION

It is now well known that the satellite ion states in atoms and molecules arise from correlation effects involving the simultaneous ejection of one electron and the excitation of another electron upon the absorption of a single photon. In the case of Ar, TPE spectroscopy has proven very useful in studying the valence satellite ionization region.[1-3] Numerous satellite ion and resonance states have been discovered and assigned. In this work, because a higher resolution was achieved (by a factor of 4 or more) than in any previous study, we observe many new satellite ion and resonance states. In some cases we observed satellite ion states predicted on the basis of

expectation but not actually observed as resolved peaks. An expanded view of our high-resolution TPE spectrum of Ar in the main satellite ionization region is shown in Fig. 2.

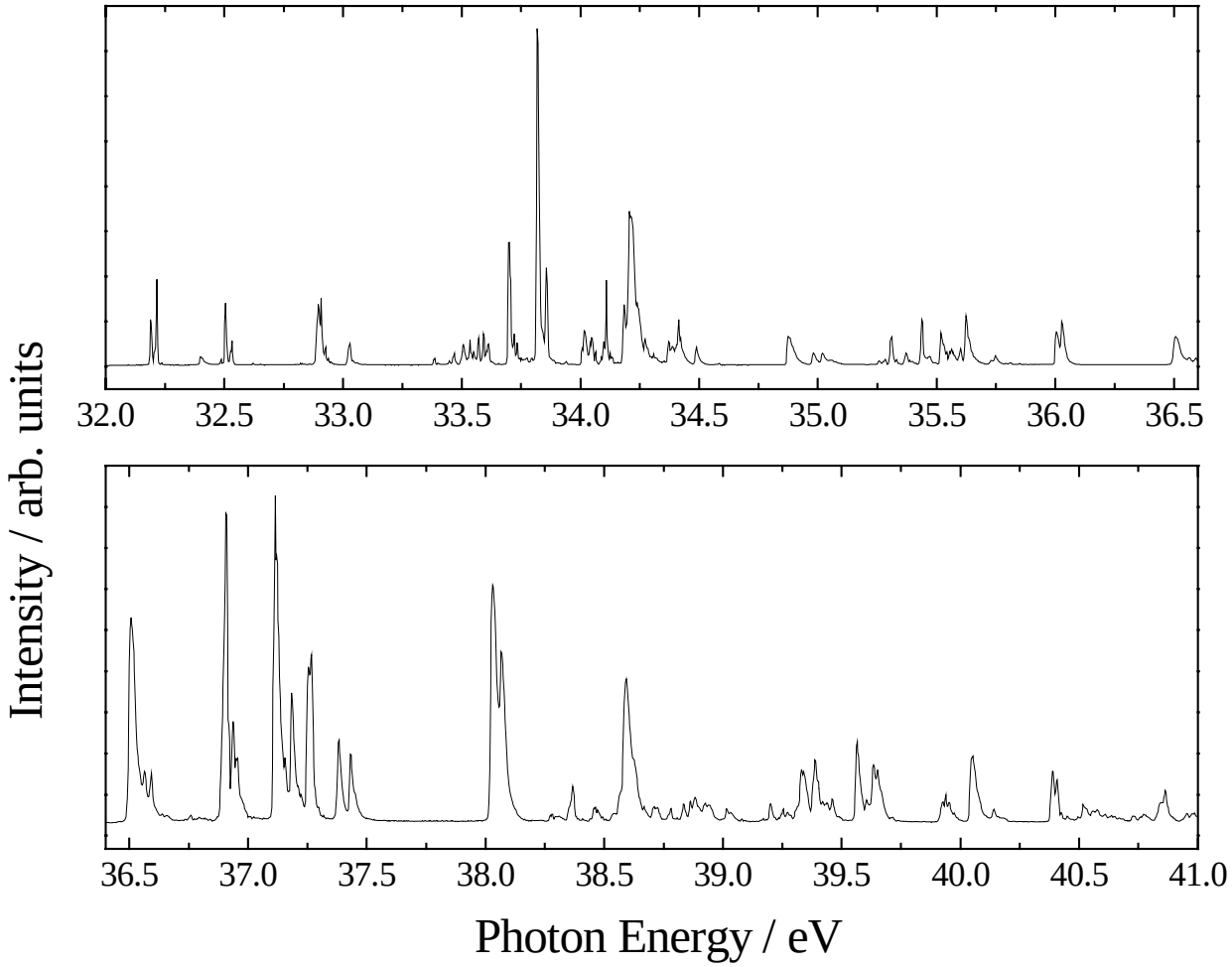


Figure 2. Expanded view of the high-resolution threshold photoelectron spectrum of Ar in the main satellite ionization region.

One interesting aspect of this TPE study is the first observation of a number of rather broad peaks immediately preceding the $(3s)^{-1}$ main line of $Ar^+$ as shown in Fig. 3. We tentatively identify these as being due to the formation of neutral $(3s^1 3p^6)$ *nl* Rydberg states converging on the $^2S_{1/2}$ ion state. We believe these states are detected by us as near threshold (3 meV) electrons via autoionization of the $(3s^2 3p^5)$ *11s'* Rydberg state forming the $Ar^+$ ($^2P_{3/2}$) ion following fluorescence from the initially formed Rydberg states. A complete analysis of the TPE spectrum is currently underway.

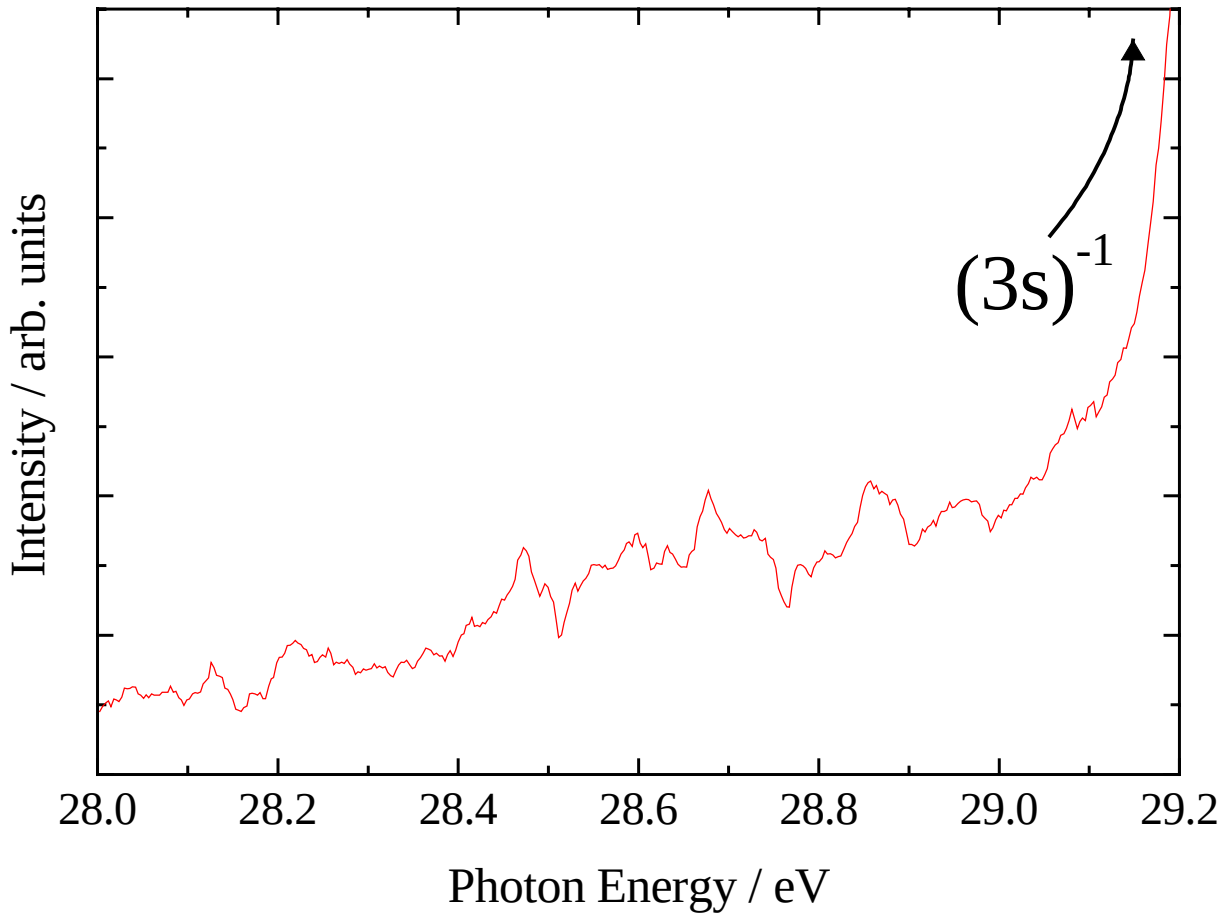


Figure 3. Neutral Ar resonances preceding the $(3s)^{-1}$ main line of $Ar^{+}$ in the threshold photoelectron spectrum.

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Principal investigators: A.J. Yencha. Email: AJY26@cnsvax.albany.edu; G.C. King. Email: GCK@fs3.ph.man.ac.uk; M.C.A. Lopes. Email: criss@fisica.ufjf.br